**Before the**
**Federal Communications Commission**
**Washington, D.C. 20554**

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|---|---|---|
| In the matter of | ) | |
| | ) | |
| Establishment of an Interference Temperature | ) | |
| Metric to Quantify and Manage Interference | ) | ET Docket No. 03-237 |
| and to Expand Available Unlicensed | ) | |
| Operation in Certain Fixed, Mobile and | ) | |
| Satellite Frequency Bands | ) | |

# COMMENTS OF COMSEARCH

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**SUMMARY**

Comsearch, a division of Andrew Corporation specializing in spectrum management for microwave and satellite communications systems, agrees that increased sharing in the 6,525-6,700 MHz and 12,750-13,250 MHz bands is feasible using streamlined coordination methods. However, we are opposed to the trial implementation of Interference Temperature operation based on Dynamic Frequency Selection (DFS) and Transmitter Power Control (TPC) that is proposed in the NPRM, because we believe that it would cause harmful interference to fixed service receivers. Instead the FCC should consider streamlined coordination approaches that take into account critical factors like the location of the transmitters and receivers, transmitter powers, path distances, antenna pointing directions, antenna discrimination values, and receiver sensitivities.

Because there is no widespread noise floor degradation from interference in the 6,525-6,700 MHz and 12,750-13,250 MHz bands, performance of FS receivers is noise-limited. Under the Interference Temperature concept, there is no natural "margin" to be captured for use by an unlicensed underlay service. The FCC should therefore establish Interference Temperatures for these bands that limit noise floor degradation to no more than a nominal value such as 1 dB.

DFS cannot protect FS receivers from harmful interference because there is no connection between the level that an unlicensed device may receive from an FS transmitter, and the interference that that device's transmissions may cause to the associated FS receiver. Based on a detailed analysis of several example link budgets we conclude there is no way to select a DFS threshold that is both low enough to protect the FS receivers and high enough to allow a viable unlicensed underlay service.

Thus we urge the FCC to abandon the proposed trial of Interference Temperature (DFS and TPC) operation of unlicensed devices in the 6.7 and 13 GHz bands. Instead the Commission should investigate other strategies for allowing additional devices to share the band.

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**Comments of Comsearch**

Comsearch, pursuant to §1.415 of the FCC rules, hereby respectfully submits the following comments in response to the Notice of Inquiry and Notice of Proposed Rulemaking in the above captioned proceeding.

## I. INTRODUCTION

Comsearch, a division of Andrew Corporation, is an engineering firm specializing in spectrum management of terrestrial microwave, satellite, and mobile telecommunications systems. Comsearch interacts with the Commission and the National Telecommunications and Information Administration (NTIA) and actively participates in various industry groups such as the National Spectrum Managers Association (NSMA), the Telecommunications Industry Association (TIA), Institute of Electrical and Electronics Engineers (IEEE), and the Wireless Communications Association International (WCA) to develop rules, industry recommendations, and standards to promote the efficient use of the radio spectrum. Since

1977, Comsearch has been a leading provider of engineering services and software for mobile, microwave, and satellite communications systems, both domestically and internationally. In this role, we have gained extensive experience in developing industry-standard coordination processes, developing and maintaining state-of-the-art software and databases, performing interference analyses of complex environments, and understanding regulatory requirements.

In the Notice of Inquiry (NOI) the Commission is seeking comment on a proposed new model for quantifying and managing interference called "interference temperature". This concept was initially developed by the Commission's Spectrum Policy Task Force to improve the management of the radio spectrum. In the Notice of Proposed Rulemaking (NPRM), the Commission is seeking comment on the specific technical rules that would establish the interference temperature concept in the 6,525-6,700 MHz and 12,750-13,250 MHz bands used by the fixed service (FS) and fixed satellite service (FSS).

A primary area of our expertise is in frequency management of microwave and satellite communications systems and we will therefore limit our comments to the NPRM portion of the proceeding. In the NPRM the Commission is promoting additional sharing in the selected bands between licensed FS and FSS systems and unlicensed devices. While we agree that the bands can support increased sharing, and that a streamlined system of spectrum management is a sound goal, we do not find the NPRM proposals sufficient to protect FS receivers from harmful interference.

The existing emission limits above 960 MHz for unlicensed devices allow an EIRP level of –41.25 dBm/MHz.[1] A device transmitting at this level is capable of degrading the noise floor of a microwave receiver at a distance of several kilometers if the device happens to be located in the main beam of the microwave antenna.[2] Licensed FS and FSS stations are able to share the spectrum at much higher EIRP levels, despite the corresponding interference potential over greater distances, as a result of the careful planning that occurs during frequency coordination of these stations. Significantly increasing the allowable EIRP for unlicensed devices as proposed in the NPRM, perhaps to +36 dBm, carries with it a huge potential for causing harmful interference unless a spectrum management regime that is as effective as the existing Part 101 coordination process is implemented. Unfortunately, Interference Temperature as proposed in the NPRM would not be effective.

Regarding interference from unlicensed devices into FS receivers, the NPRM raises two major questions that must be addressed:

- What level of interference is harmful to FS receivers?
- Can the proposed implementation of the Interference Temperature concept protect FS receivers from harmful interference?

[1] See NPRM at footnote 34.

[2] With a typical microwave receiver noise figure of 5 dB, the noise in a 10 MHz bandwidth at 6.7 GHz is –99 dBm. To limit the degradation of the receiver threshold to 1 dB or less, the interference objective would be –105 dBm. Including 42 dBi gain of the microwave receive antenna, and assuming the unlicensed device transmits a uniform power density of –41.25 dBm/MHz across the 10 MHz microwave bandwidth, path loss of 115.75 dB (-41.25+10+42+105) would be required to meet the interference objective. Under free space propagation conditions, 2.2 km distance is required.

## II. WHAT LEVEL OF INTERFERENCE IS HARMFUL TO FS RECEIVERS?

The FCC comments in the NPRM that "Some systems, especially those employing error correction codes and other interference mitigation techniques are highly robust and can operate in the presence of an undesired signal that is considerably higher than the level of the desired signal without experiencing harmful interference. In view of the typical usage by FS stations of low modulation indices and/or amplitude modulation, our general experience indicates that a S/I ratio in the range of 30 dB to 50 dB should be more than sufficient to ensure that harmful interference is not caused to a fixed service operation."[3]

While some spread-spectrum systems may be able to operate with an undesired signal higher than the desired signal, FS systems under Part 101 are not able to use such techniques because of the spectrum efficiency requirements imposed by 47 C.F.R §101.141. Considering the communication engineer's axiom of "trading bandwidth for signal-to-noise ratio", the rule requires a high data rate for the allowed bandwidth, and therefore a high ratio of signal power to noise and interference is necessary. To meet the required bandwidth efficiency of 4.5 bps/Hz, it is necessary to use high-order digital modulation schemes such as 64 QAM. Instead of being able to operate with a negative C/(N+I), these systems require large positive C/(N+I) values of 25 to 30 dB or more just to demodulate the signal at an acceptable bit error rate of $10^{-6}$. Further, to meet the stringent reliability objectives necessary for these systems, a significant fade margin must be included in the interference objectives to account for periods of time when the desired signal suffers a deep multi-path fade while the interference signal

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[3] NPRM at ¶42.

remains constant. Determining the interference objectives by the T/I approach of TIA TSB 10-F limits degradation of the receiver threshold to no more than 1 dB, and typical C/(N+I) objectives for the 6.7 GHz band are in the 55 to 75 dB range. The need for such high C/(N+I) ratios is not the result of poor design of the FS systems but rather is the result of the basic system requirements – the need to transmit a high data rate signal in a narrow radio channel, the fact that multi-path fading is independent among paths in an area, and the necessity to meet stringent path reliability objectives.

### A. Widespread Noise Floor Degradation Does Not Exist in the 6.7 and 13 GHz Bands

As depicted in Figure 1,[4] the interference temperature concept depends on the idea that interference signals often prevent receivers from operating down to the threshold they could achieve based on thermal noise alone. In this scenario, there is an appreciable likelihood of existing interference above the thermal noise floor, and setting an Interference Temperature limit will allow unlicensed devices to cause similar interference somewhat above the receiver thermal noise floor while at the same time placing a cap on the total interference that a receiver should be expected to suffer. Conceptually, this situation may apply to, for example, land mobile and broadcasting bands below 1 GHz where there is significant noise floor degradation as a result of man-made interference sources, but it does not apply to microwave bands above 1 GHz where there is no such widespread noise floor degradation.

[4] See NOI, Figure 1.

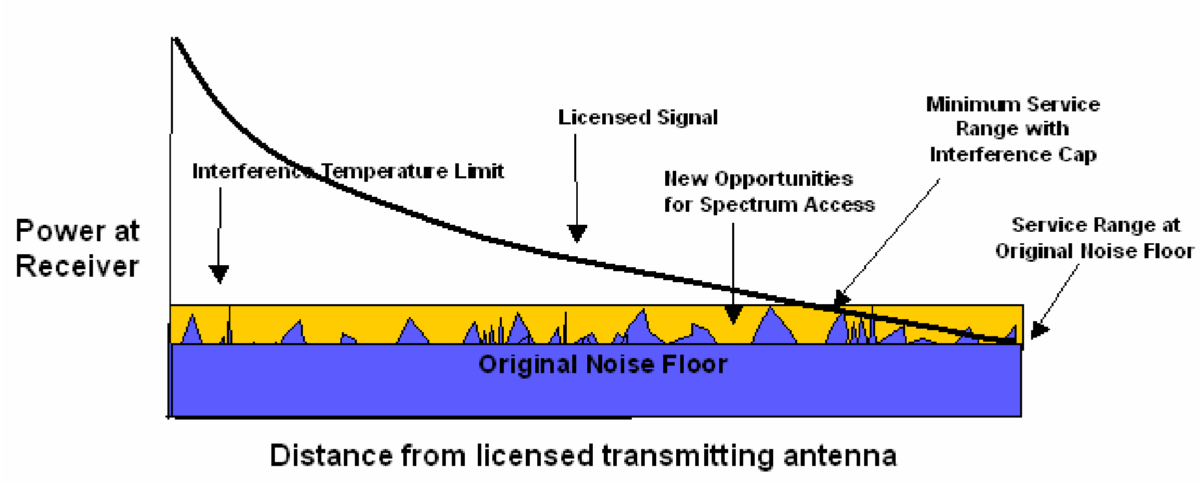



**Figure 1**

The Report of the Second Meeting of the FCC Technological Advisory Council III states: "Investigators also found that classical man-made noise from machinery and ignition systems was generally not observable above 500 MHz. Now, however, we must contend with "new noise" from UWB and Part 15 low-power unlicensed devices as noise sources." There is no existing interference noise from classical sources, and because UWB devices are not yet widely deployed and Part 15 devices are presently limited to very low power levels in the 6.7 and 13 GHz bands, we can conclude that by-and-large there is no existing degradation of the noise floor in these bands.

### B. Interference Objectives Should Protect the Noise Floor of Fixed Service Receivers

In contrast to the interference scenario of Figure 1, FS receivers are almost always noise-limited. Because of the careful frequency planning and coordination used to select the FS link parameters (frequency, polarization, power, etc.), widespread noise floor degradation does not occur in the 6.7 and 13 GHz bands. Therefore engineers can depend on operation down to the receiver's data sheet threshold as they design links. A common acceptance test performed on microwave links after installation is a fade margin test to verify operation of the receivers down to the manufacturer's stated threshold level (based on thermal noise). Such testing almost always shows no degradation of the receiver threshold from external interference.

Because widespread noise floor degradation does not exist in the 6.7 and 13 GHz bands, there is no natural "margin" to be captured for use by an unlicensed underlay service. Setting an Interference Temperature limit that allows more than 1 dB of degradation of the threshold of microwave receivers would directly harm licensed microwave systems in favor of the new unlicensed service. The Commission should set the Interference Temperature limit at 6 dB below the noise floor of the FS receivers. Table 1 shows typical interference limits for several 6.7 GHz and 13 GHz microwave systems. There may be a large number of unlicensed devices contributing to the interference into a FS receiver, and the total interference from these devices should be expected to meet the objectives in Table 1.

| Frequency Band (MHz) | System Type | Receiver Noise Figure (dB) | Receiver Thermal Noise Power Density (dBm/MHz) | Interference Power Density Objective (dBm/MHz) | Receiver Bandwidth (MHz) | Receiver Thermal Noise Power (dBm) | Interference Objective (dBm) |
|---|---|---|---|---|---|---|---|
| 6,525-6,700 | FM/FDM | 7.0 | -107.0 | -113.0 | 5.0 | -100.0 | -106.0 |
| 6,525-6,700 | FM/FDM | 7.0 | -107.0 | -113.0 | 10.0 | -97.0 | -103.0 |
| 6,525-6,700 | Digital | 4.0 | -110.0 | -116.0 | 5.0 | -103.0 | -109.0 |
| 6,525-6,700 | Digital | 4.0 | -110.0 | -116.0 | 10.0 | -100.0 | -106.0 |
| 12,750-13,250 | AM/VSB/Video | 8.0 | -106.0 | -112.0 | 6.0 | -98.2 | -104.2 |
| 12,750-13,250 | FM/Video | 8.0 | -106.0 | -112.0 | 12.5 | -95.0 | -101.0 |
| 12,750-13,250 | FM/Video | 8.0 | -106.0 | -112.0 | 25.0 | -92.0 | -98.0 |
| 12,750-13,250 | Digital | 4.0 | -110.0 | -116.0 | 12.5 | -99.0 | -105.0 |
| 12,750-13,250 | Digital | 4.0 | -110.0 | -116.0 | 25.0 | -96.0 | -102.0 |

**Table 1**

Higher levels of interference should only be allowed if

a) The FS receiver has excess fade margin. Threshold degradation in excess of 1 dB may be acceptable if the receiver still meets its reliability objective based on the appropriate path fading models.

b) The interference is intermittent rather than constant. This situation may apply if the unlicensed devices transmit with less than full duty cycle; on the other hand there may be no advantage if there are a large number of devices. An approach such as Fractional Degradation of Performance (FDP)[5] could be used to quantify this interference. FDP of 25% corresponds to 1 dB degradation from a constant interference source.

c) The interference is removed when the FS receivers fade. In other words, the FS receivers control the unlicensed transmitters.

## III. CAN THE PROPOSED IMPLEMENTATION OF INTERFERENCE TEMPERATURE PROTECT FS RECEIVERS FROM HARMFUL INTERFERENCE?

### A. Lower EIRP of Unlicensed Devices Versus Fixed Service Transmitters Is Not Sufficient to Protect FS Receivers From Harmful Interference

In the NPRM the Commission states that "in light of the great disparity in magnitude between permissible emission levels for licensed versus unlicensed devices, sound engineering judgment intuitively suggests that the 6,525-6,700 MHz and 12.75-13.25 GHz bands can

[5] See Recommendation ITU-R F.1108.

support expanded unlicensed operations enabled by an interference temperature approach without detrimental impact to incumbent operations."[6] The Commission thus appears to suppose that FS receivers will be protected from harmful interference despite a 77 dB increase in the EIRP allowed to unlicensed devices,[7] because the allowed EIRP would still be 49 dB below the EIRP level allowed to licensed FS transmitters.[8] Lower EIRP of unlicensed devices by itself is not enough to protect FS receivers. Part 15 presently allows +36 dBm EIRP in the 5,725-5,850 MHz band,[9] and because no directional antenna requirements are included with the Commission's proposals, we presume that the NPRM contemplates allowing the same operation in the 6.7 GHz and 13 GHz bands: EIRP of +36 dBm using an omni-directional antenna. Typical FS operation in the 6.7 GHz band might involve a 1 W transmitter connected to an 8-foot diameter parabolic antenna for a maximum main beam EIRP of about +70 dBm. Considering the pattern of the Andrew PAR8-65 antenna, the EIRP of this setup would be less than +36 dBm for all angles more than 3.5 degrees from the boresight direction, and would be just +10 dBm for a 100 degree sector behind the antenna. The Commission must recognize that the area of potential interference created by a +36 dBm EIRP omni-directional unlicensed device may be significantly larger than that of a +70 dBm EIRP FS transmitter using a typical directional microwave antenna. Introducing omni-directional unlicensed transmitters to the bands has a huge potential for causing interference to FS

[6] NPRM at ¶37.

[7] The NPRM proposes a maximum EIRP of +36 dBm for unlicensed devices versus the present Part 15 limit of –41.25 dBm/MHz.

[8] The proposed maximum EIRP of +36 dBm for unlicensed devices is 49dB below the +85 dBm EIRP allowed to FS transmitters.

[9] The +36 dBm EIRP results from connecting a 1 W transmitter to a 6 dBi omni-directional antenna.

receivers, even if the EIRP level allowed to the unlicensed transmitters is much lower than that of the FS transmitters.

### B. Dynamic Frequency Selection Cannot Prevent Harmful Interference to Fixed Service Receivers

It is shown in ITU-R M.1652 that if an unlicensed device cannot detect a power level above –62 dBm on a particular channel, then its transmissions at +30 dBm EIRP on that channel would not cause harmful interference to radar systems.[10] Based on such analysis, the DFS thresholds set for the 5.25-5.35 GHz and 5.470-5.725 GHz bands, -62 dBm for devices of up to 23 dBm EIRP and –64 dBm for devices of 23 dBm to 30 dBm EIRP, are appropriate to protect radars from harmful interference. DFS is a workable solution for radar interference because:

- To overcome the path losses experienced as the signal travels to and returns from an object, radars must transmit extremely high power levels, and these signals are correspondingly easy for an unlicensed device to detect.
- The path the radar signal travels from the radar transmitter to the unlicensed device is the same as the path of potential interference from the unlicensed device to the radar receiver
- Radars use antenna scanning to direct the main beam in multiple directions, increasing the ability of unlicensed devices to detect the signal

Conversely, DFS is not a workable solution to prevent harmful interference to the fixed service because:

[10] Seventeen of eighteen radar systems analyzed required a DFS threshold above –62 dBm.

- FS transmitters use only moderate EIRP levels and directional antennas that greatly suppress the radiated EIRP in all but the direction of the main beam. This makes the signal very difficult or impossible for an unlicensed device to detect.
- The path the signal travels from FS transmitter to the unlicensed device is not the same as the path of potential interference from the unlicensed device to the FS receiver.
- Because the "detection path" and "interference path" are different, there is no connection between the level that an unlicensed device may detect on a channel, and the interference effect of its transmissions on that channel. While unable to detect the FS transmitter signal, an unlicensed device could be in the main beam of the FS receiver antenna and capable of causing catastrophic interference to the receiver. A device may not hear any use of the channel but cause catastrophic interference, or may hear a relatively high signal on the channel but not cause harmful interference.

### C. Example Link Budgets

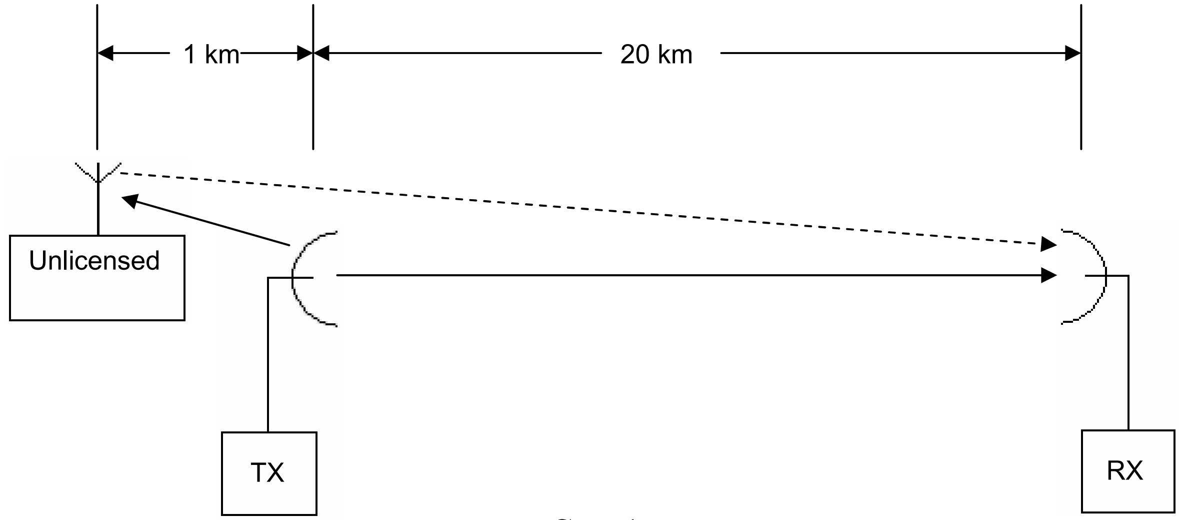
We believe the Commission's sharing analysis between the FS and unlicensed devices[11] is flawed because of several inaccurate assumptions. First, the Commission assumes that there would always be at least 20 degrees antenna discrimination from a FS receive antenna towards an unlicensed transmitter. However, at much greater distances than the 100 meter distance the Commission was considering, it is very possible that an unlicensed transmitter could be in the main beam of the FS receive antenna. Furthermore, harmful interference is

[11] See NPRM at ¶¶ 40-43.

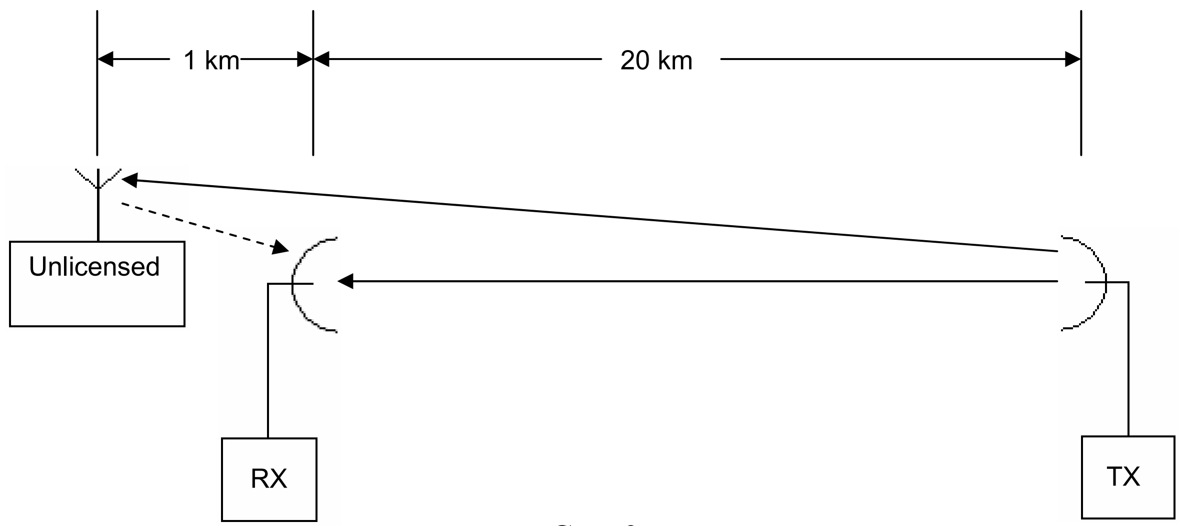
quite possible at these greater distances because of the sensitivity of the FS receivers. Second the Commission's analysis does not consider the effect of discrimination from the FS transmit antenna towards the unlicensed device, or the effect of the use of ATPC by the FS transmitter. This discrimination and ATPC power reduction make it difficult or impossible for the unlicensed device to detect FS use of the channel. Finally, the Commission's analysis assumes that "unwanted emissions received by the FS receiver will be dominated by the emissions from the closest [unlicensed] device."[12] Instead, devices that are farther away but in the main beam of the FS receive antenna may dominate unwanted emissions received by the FS receiver.

We present the following examples to illustrate the fact that it is impossible for DFS to manage or prevent harmful interference to FS receivers.

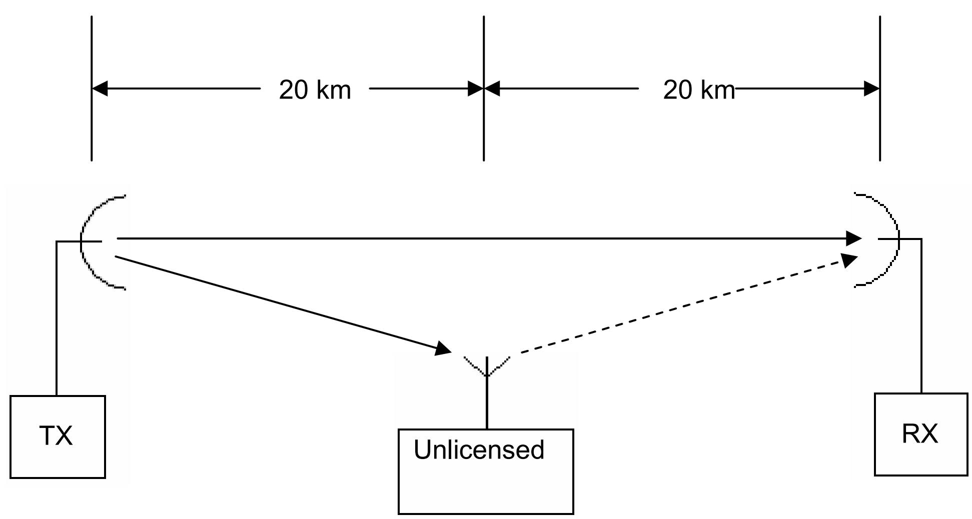
[12] See NPRM at ¶ 41.




**Case 1**




**Case 2**




**Case 3**

| Case Parameters | Case 1 | Case 2 | Case 3 |
|---|---|---|---|
| Frequency (GHz) | 6.7 | 6.7 | 6.7 |
| FS Transmitter Power (dBm) | 27 | 27 | 27 |
| FS TX Station Fixed Losses (dB) | 3 | 3 | 3 |
| FS TX Antenna Mainbeam Gain (dBi) | 39.5 | 39.5 | 42.3 |
| FS EIRP (dBm) | 63.5 | 63.5 | 66.3 |
| FS TX Antenna Discrimination to Unlicensed Device (dB) | 70 | 0 | 0 |
| Distance - FS Transmitter to Unlicensed Device (km) | 1 | 21 | 20 |
| Free Space Path Loss - FS Transmitter to Unlicensed Device (dB) | 109.0 | 135.4 | 135.0 |
| Additional Shielding Loss - FS Transmitter to Unlicensed Device (dB) | 0 | 0 | 0 |
| Signal Level - FS Transmitter at Unlicensed Device Ref to 0 dBi (dBm) | -115.5 | -71.9 | -68.7 |
| Meets -64 dBm DFS Threshold Criterion by (dB) | 51.5 | 7.9 | 4.7 |
| Unlicensed Device Transmitter Power (dBm) | 30 | 30 | 30 |
| Unlicensed Device Antenna Gain (dBi) | 6 | 6 | 6 |
| Unlicensed Device EIRP (dBm) | 36 | 36 | 36 |
| Distance - Unlicensed Device to FS Receiver (km) | 21 | 1 | 20 |
| Free Space Path Loss - Unlicensed Device to FS Receiver (dB) | 135.4 | 109.0 | 135.0 |
| Additional Shielding Loss - Unlicensed Device to FS Receiver (dB) | 0 | 0 | 0 |
| FS RX Antenna Mainbeam Gain (dBi) | 39.5 | 39.5 | 42.3 |
| FS RX Antenna Discrimination to Unlicensed Device (dB) | 0 | 70 | 0 |
| FS RX Station Fixed Losses (dB) | 3 | 3 | 3 |
| Interference Level - Unlicensed Device at FS Receiver (dBm) | -62.9 | -106.5 | -59.7 |
| FS RX Noise Bandwidth (MHz) | 10 | 10 | 10 |
| FS RX Noise Figure (dB) | 5 | 5 | 5 |
| FS RX Thermal Noise Power (dBm) | -99.0 | -99.0 | -99.0 |
| FS Interference Objective for 1 dB Threshold Degradation (dBm) | -105.0 | -105.0 | -105.0 |
| Interference Level Misses Objective By (dB) | 42.1 | -1.5 | 45.3 |
| Distance - FS Transmitter to FS Receiver (km) | 20 | 20 | 40 |
| Free Space Path Loss - FS Transmitter to FS Receiver (dB) | 135.0 | 135.0 | 141.0 |
| FS Carrier Level (dBm) | -35.0 | -35.0 | -35.4 |
| FS Required C/(N+I) @ 10^-6 BER (dB) | 25 | 25 | 25 |
| FS Receiver Threshold @ 10^-6 BER (dB) | -74.0 | -74.0 | -74.0 |
| FS Fade Margin w/o Interference (dB) | 39.0 | 39.0 | 38.6 |
| FS Reliability w/o Interference - Average Propagation Conditions (%) | 99.99990 | 99.99990 | 99.99910 |
| FS RX Thermal Noise Power plus Interference (dBm) | -62.9 | -98.3 | -59.7 |
| Degraded FS Receiver Threshold with Interference (dBm) | -37.9 | -73.3 | -34.7 |
| FS Fade Margin with Interference (dB) | 2.9 | 38.3 | -0.7 |
| FS Reliability with Interference (%) | 95.93050 | 99.99988 | - |

**Table 2**

In Case 1, an unlicensed device is located 1 km behind the transmitting antenna of a 20 km FS link and in the main beam of the receiving antenna of the link. In this configuration, the discrimination of the transmitting FS antenna makes it difficult or impossible for the unlicensed device to detect the FS use of the channel. At the same time, the transmissions of the unlicensed device would cause severe interference to the FS receiver. In Table 2 a link budget for Case 1 based on realistic parameters shows that the level of the signal of the FS transmitter at the unlicensed device would be –115.5 dBm referenced to a 0 dBi antenna, while the level of the interference signal from the unlicensed device at the FS receiver would be –62.9 dBm. It is questionable whether the unlicensed device could hear the FS signal, since the level would be comparable to the noise floor of a conventional receiver, while the interference of the unlicensed device would take nearly all the fade margin of the FS receiver and reduce the link reliability from 99.9999% to 96%. To avoid harmful interference in Case 1, either the DFS threshold would have to be set at –116 dBm so the unlicensed device would not transmit, or the unlicensed device EIRP would have to be limited to –6 dBm so the interference level would meet the objective. Such limits do not appear to allow for a viable unlicensed underlay service. Furthermore, if the unlicensed device were 4 km instead of 1 km behind the FS transmit antenna, the FS signal at the unlicensed device would be reduced 12 dB to –127 dBm0 while the interference signal of the unlicensed device at the FS receiver would only be reduced 1 dB. At some point the unlicensed device would become unable to detect the presence of the FS transmitter and would have no basis upon which to make its transmit or do not transmit decision.

Traditionally, the Commission has adopted rules that require licensees to use the minimum transmitter power necessary and to use antennas that minimize the impact on other users. Such rules are rightly seen as encouraging efficient use of the spectrum. However, allowing unlicensed devices with DFS into the microwave bands would create opposite incentives for FS users. Table 1 shows a front-to-back ratio of 70 dB for the FS transmit antenna. This value corresponds to an ultra-high performance antenna. On the other hand, the Part 101 antenna standards only require front-to-back discrimination of 45 dB for Category B and 55 dB for Category A in the 6.7 GHz band.[13] If the microwave path used Category B antennas instead of ultra-high performance antennas, the decrease in antenna discrimination would make the FS signal easier to detect at the unlicensed device and increase the chance that the unlicensed device would decide not to transmit. Thus by allowing unlicensed devices with DFS into the FS bands, the Commission would be creating an incentive for FS licensees to use the worst antennas that they could get away with. Similarly, FS licensees would have an incentive to use the highest transmitter power that they could, and an incentive not to use ATPC. If the FS link in Case 1 used an ATPC that reduced the transmitter power 10 dB, the unlicensed device would be that much less likely to detect the FS transmitter, and the interference from the unlicensed device would render the link unavailable even without any fading of the link.

In Case 2, an unlicensed device is located 1 km behind the receiving antenna of a 20 km FS link and in the main beam of the transmitting antenna of the link. Thus the geometry of the case is opposite that of Case 1. Here, the level of the FS transmitter at the unlicensed device is –71.9 dBm0 (much higher than Case 1), while the interference level of the unlicensed device at the FS receiver is –106.5 dBm (much lower than Case 1). In the geometry of Case 2, the unlicensed device would be able to detect the FS transmitter, and the interference caused by the unlicensed transmitter to the FS receiver would meet the interference objective. Since the interference would meet the objective, the DFS threshold of –64 dBm proposed in

[13] See 47 C.F.R §101.115(c).

the NPRM would be acceptable for Case 2. However if the DFS threshold were set low enough to protect the FS receiver for the geometry of Case 1, then the DFS threshold would be exceeded in the geometry of Case 2, and the unlicensed device would decide it could not transmit.

In Case 3, an unlicensed device is located in the middle of a 40 km FS link. Even in this geometry, the level of the FS transmitter at the unlicensed device, -68.7 dBm0, meets the proposed DFS threshold. The device would decide it could transmit, but the interference level at the FS receiver, -59.7 dBm, would render the link unavailable.

The results of Cases 1, 2, and 3 may be summarized as follows:

| | Level of FS Transmitter at Unlicensed Device | Interference Level of Unlicensed Device at FS Receiver |
|---|---|---|
| Case 1 | Low | High |
| Case 2 | High | Low |
| Case 3 | High | High |

**Table 3**

From this we conclude there is no connection between the level that an unlicensed device may receive from an FS transmitter, and the interference that that device's transmissions may cause to the associated FS receiver. There is no way to select a DFS threshold that is both low enough to protect the FS receivers and high enough to allow a viable unlicensed underlay service.

## IV. OTHER TECHNICAL ISSUES

In paragraph 43 and footnotes 42 and 43 of the NPRM, the Commission advances an argument under which, using certain assumptions about path losses, antenna discrimination values, and C/I requirements, an unlicensed device in the 6.7 GHz band should be able to transmit a power level 91 to 71 dB higher than it received from a FS transmitter without causing harmful interference to the FS receiver. Similarly, an unlicensed device in the 13 GHz band should be able to transmit a power level 95 to 75 dB higher. Following the Commission's arguments here, the more signal power an unlicensed device would receive on a channel, the more power it would decide it could transmit. Conversely, the less signal power the device would receive, the less power it would decide it could transmit. This argument leads to the conclusions that if an unlicensed device could not detect any use of the channel, it would decide that it could not transmit, and if it detected a high signal level on the channel it would decide that it could transmit at maximum power. On the other hand, in paragraph 44 of the NPRM, the Commission proposes the use of Dynamic Frequency Selection (DFS) as developed previously to avoid causing interference to radar systems in the 5,250-5,350 and 5,470-5,725 MHz bands. An unlicensed device using DFS would monitor the channel and decide it could transmit if the level was below the DFS threshold. The device would decide it could not transmit if the level was above the DFS threshold. Thus operation under the "EIRP margin" argument of paragraph 43 and footnotes 42 and 43, and operation under DFS as proposed in paragraph 44, are essentially opposite proposals in terms of the decision to transmit or not to transmit based on the "interference temperature".

The NPRM also suggests that the level of FS transmissions could be monitored at centralized control stations that would then give the unlicensed devices instructions on the frequencies that could be used. This configuration makes just as little sense as DFS by the individual unlicensed devices.

The NPRM proposes transmitter power control (TPC) as part of Interference Temperature spectrum management for the 6.7 and 13 GHz bands, but does not make any specific proposal as to how TPC would work with DFS. The NPRM asks if TPC should be required to reduce the transmitter power by more than 6 dB below maximum.[14] We agree that TPC could be a useful means of reducing the average interference power entering FS receivers from unlicensed transmitters; however, given the magnitude of the potential interference exposures as illustrated by Cases 1 and 3 above, 6 dB TPC power reduction is wholly inadequate to mitigate the interference. We are doubtful that TPC is a practical solution to provide the more than 40 dB improvement required to resolve these cases.

Because we feel that the potential interference caused to the FS, the chief users of the 6.7 and 13 GHz bands, presents a compelling case against adopting the Interference Temperature proposals of the NPRM, we choose not to discuss the potential interference caused to the FSS in detail. We do wish to mention, however, that the results of the Commission's analysis in Appendix B appear to be strongly dependent on the assumption that outdoor Part 15 devices would use directional antennas and would have significant discrimination towards the geostationary satellite arc. In spite of this, the NPRM does not contain any proposed rules

[14] See NPRM at ¶ 45.

requiring the use of directional antennas, and furthermore we believe it is possible that some Part 15 devices could use directional antennas pointed towards GSO satellites.

## V. CONCLUSION

The FCC should abandon the proposed trial implementation of Interference Temperature (DFS and TPC) operation of unlicensed devices in the 6.7 and 13 GHz bands because it has no hope of protecting the FS from harmful interference while at the same time allowing a viable unlicensed underlay service. Instead the Commission should investigate realistic strategies for allowing unlicensed devices to share the band. Such realistic strategies could include:

- Control of the unlicensed transmitters by the FS receivers
- Mandatory registration of unlicensed devices in frequency coordination databases and up-front interference analysis
- Real-time self-coordination of unlicensed devices by using new software algorithms, GPS positioning, and up-to-date downloads of local FS link data
- Directional antenna requirements for the unlicensed devices

The Commission states, "we believe that the use of TPC and DFS can automatically mimic [frequency coordination], but in real time as opposed to manual human coordination activities."[15] The implementation of Interference Temperature proposed in the NPRM cannot replace the present frequency coordination because it ignores critical factors like the location of the transmitters and receivers, transmitter powers, path distances, antenna pointing directions, antenna discrimination values, and receiver sensitivities. Automating frequency coordination must involve detailed interference calculations that take these factors into

[15] See NPRM at ¶ 45.

account. An oversimplified solution as the Commission has proposed in this NPRM can only lead to harmful interference to the FS, unreasonably restrictive limits on the unlicensed service, or both.

Respectfully Submitted,

**COMSEARCH**
19700 Janelia Farm Boulevard
Ashburn, Virginia 20147

Prepared by:__________________
William W. Perkins
Principal Engineer

Date: April 5, 2004